The BART Experience – What Have We Learned?

by MELVIN M. WEBBER

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THE Bay Area Rapid Transit system (BART) has many characteristics of a huge social experiment —in vivo, as it were. Key element in a bold scheme to structure the future of the San Francisco region, BART was to stem the much-feared decline of the older metropolitan centers, while helping to give coherent order to the exploding suburbs. By offering a superior alternative to the automobile, BART was to make for congestion-free commuting. If successful, it would provide a model for rationalizing transportation and metropolitan development elsewhere.

It was experimental only in the sense that nothing quite like it had ever been tried before. Nowhere in America had a regional rail system been built in contemporary times, and nowhere in the world had such a rail system been built in an auto-based metropolitan area. Although novelty inevitably implied risk, BART was nevertheless promoted with the high confidence, if not certainty, that governmental projects seem to require. Its developers saw it as a sure bet.

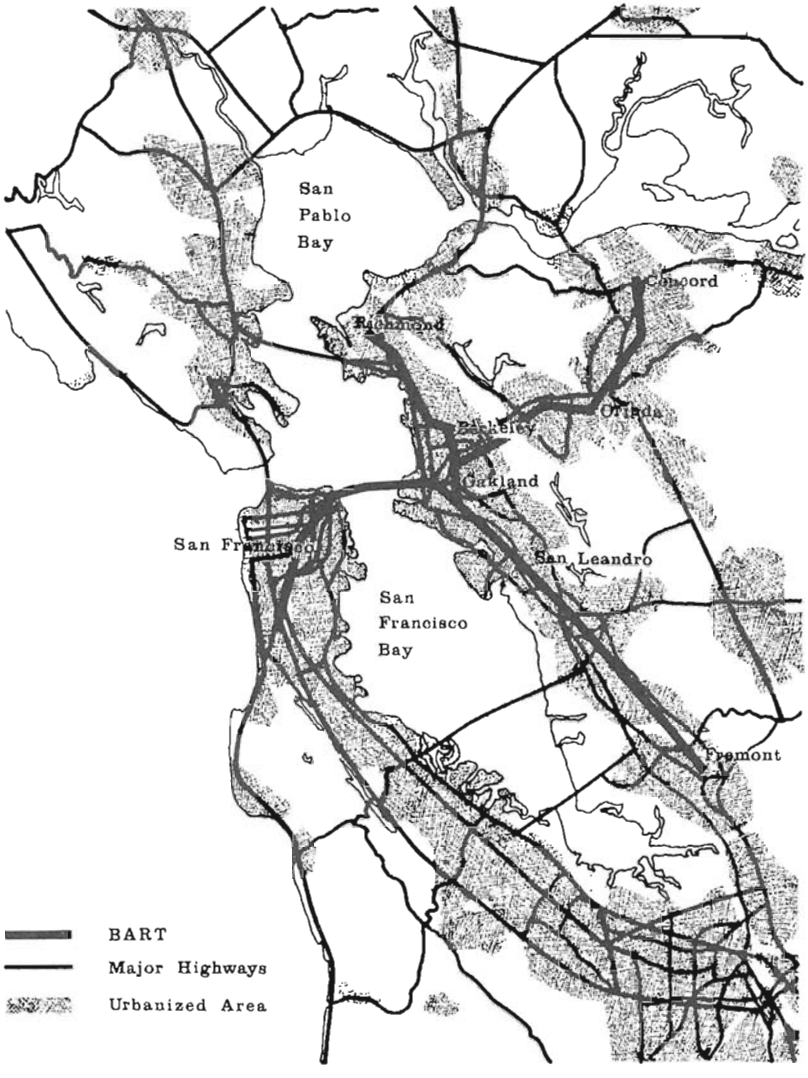
They could not have chosen a better test site. The auto-ownership rate in the Bay Area is one of the world's highest, and auto-using habits are firmly entrenched, fostered by an early full-freeway system. The metropolitan region is built around a traditional European-type center with a large concentration of office employ-

ment and related service employment. Outside the small but high-density central city, which is set at the tip of the peninsula, the metropolitan settlement is organized in low-density suburban patterns, all of which were built around automobile transport. For test purposes, the Bay Area is further advantaged by having its urbanized areas topographically molded into narrow strips that parallel San Francisco Bay and follow the narrow valleys—a configuration superbly suited to the geometry of railroad lines, which also makes for long travel distances that, in turn, cry out for high-speed modes of transport. (The average Bay Area commuter lives 15.8 miles from his job; by comparison, Los Angeles commuters are only 8.9 miles away, Chicago commuters 6.6 miles, Philadelphia commuters 4.4 miles.) What better place, then, to test whether a technologically superior system could stem the decline of traditional public transit and at the same time compete with the automobile as the dominant commuter mode and shaper of metropolitan growth? If it didn't work here, the odds of its working in less suited areas would surely be low.

Following some protracted and perhaps inevitable construction and debugging delays, BART began carrying passengers in September 1972. In response, a massive effort has been launched to monitor its effects. The BART Impact Program is carefully watching a wide array of potential consequences, under the sponsorship of the Department of Transportation and the Department of Housing and Urban Development, with the local Metropolitan Transportation Commission in the key research and management roles. The aim is to learn what might be germane to other metropolitan areas and to derive some lessons from the Bay Area experience that might inform federal policy. Meanwhile, however, several other metropolitan areas have already developed transit schemes that resemble BART, without waiting for the findings of the Bay Area studies. Federal subsidies have already been allocated to Washington, Atlanta, and Miami; and several other cities are under consideration.

It will of course be some time before definitive results of the BART evaluation are in, but enough impact research has now been done to permit an early appraisal of how well BART is accomplishing the objectives that motivated its construction. In turn, enough has been done to permit some judgments concerning the wisdom of building BART-like systems elsewhere. As we shall see, BART's score is pretty low, implying that prospects for other cities are dim.

FIGURE I. *BART in the Bay Area*



Initial objectives

The original plans for the BART system were formulated in the mid-1950's. At that time Americans perceived the major urban policy issues to be decentralization, "urban sprawl," and the decline of the central cities, particularly of their central business districts. Federal government activities were focused upon urban-renewal programs aimed at bringing middle-class suburbanites back and rejuvenating what was dolefully mourned as the "dying

heart of the city." Some prophets were predicting an impending demise of metropolitan centers, as the automobile opened opportunities for free movement in all directions and combined with rising incomes to allow average families spacious suburban houses in spacious settings.

These prospects were greeted with exaggerated gloom in San Francisco. Surely, no other American city is as proud and narcissistic—no civic leaders elsewhere so obsessed by their sense of responsibility for protecting and nurturing their priceless charge. The idea that San Francisco might go the way of Newark or St. Louis was utterly abhorrent. And so it was, as the San Francisco Chamber of Commerce proudly reported in a multi-page advertisement in *Fortune*, that the civic leaders of San Francisco and their neighboring kin initiated a major effort to keep the Bay Area from going the way that cities of lesser breed were headed. The campaign was masterful in both conception and execution.

San Francisco had long been the major business and financial capital of the Western states, but it had been challenged since World War II by Los Angeles and, in the mid-1950's, was barely holding its own against explosive growth in Southern California. Probably as fundamental a motivation as any behind BART was the desire to keep "The City" as attractive to corporate headquarters, financial institutions, and upper-middle-class residents as it traditionally had been. Of course, those with personal economic interests in the central district were especially keen to promote BART. It would be simplistic, however, to ascribe their promotional fervor to their private considerations alone. Imbued with civic pride and the spirit of community enterprise, none doubted that he was involved in a happy symbiotic crusade in which everyone would be a winner.

The Golden Gateway redevelopment project was one response to the doom-sayers. Launched in 1955, it has by now successfully converted a decayed produce-market district into a spanking new cluster of high-rise office buildings, luxury residences, elaborate hotels, restaurants, and the like. Delayed for years by lawsuits, the Yerba Buena redevelopment project, the sister enterprise aimed at remodeling a 19th-century district lined with residential hotels, warehouses, and a skid row, may soon finally convert the "South of Market" street district from a low-class neighborhood to a prestige address. Between them, the two redevelopment efforts may total up to 10 million square feet of high-rise office space. More than that, they have contributed immensely to the prosperity of

the San Francisco central district and to its competitive posture.

So huge an expansion in floor space and commensurate office employment obviously demanded a comparable expansion in transport capacity. BART was to provide a major increase in accessibility, supplemented by extension of the freeway system and improvements in downtown parking, buses, trolley cars, cable cars, and trolley buses.

But BART was intended to do far more than bring commuters into San Francisco; it was conceived from the start as a regional system that would foster the growth of the entire Bay Area. With trains stopping on average at only 2.5-mile intervals, each station would be highly accessible, with a competitive advantage over other locations in the rivalry for apartment houses and for offices and other commercial establishments. The designers expected stations in suburban centers to attract major concentrations of offices and retail shops, while outlying stations would become surrounded by high-density housing and shopping facilities, serving commuters to the regional centers.

Simultaneously, the designers intended BART to supply the essential accessibility that would convert downtown Oakland into a major regional center. The junction of BART's four lines in the middle of Oakland's business district would indeed make that the most accessible point along BART's 71-mile route. Oakland has responded by launching its own downtown redevelopment project, which is now turning a marginal shopping area into a modern-looking business complex.

The civic leaders who promoted BART chose a rail system over additional highway improvements because they feared that the prophets of intolerable congestion might be right. The prospect that more population and more automobiles would overload the capacities of road systems seemed plausible enough to commend a system that simultaneously had a high capacity yet was conservative in its space demands. And besides, since San Francisco was a world center along with Paris, London, and New York, didn't it deserve a subway system comparable to others in its league?

Design considerations

The design criteria were thus clear: The new system had to be 1) capable of bringing increasing numbers of peak-hour commuters from near their suburban homes to within a few minutes' walk of their downtown offices, 2) attractive enough to travelers

to be more than competitive with the automobile, and 3) financially viable.

The planners' response was to design a modern, electrified suburban railroad. Believing that buses could not attain the speed necessary to make them attractive to commuters, they rejected the alternative of using them as rapid-transit vehicles. Instead, they modeled their system after the New Haven and Long Island railroads, giving it much better downtown distribution with several subway stations under the main streets of San Francisco and Oakland.[1]

BART is misnamed as a "rapid transit" system. It is a hybrid among rail transportation systems, combining features of interurban electric lines, central-city subway lines, and current suburban railway lines, with the design elegance of modern aircraft and the control instrumentation of early spacecraft. As a hybrid it represents a compromise among desirable qualities of the several transport types. Unlike the interurban electric railways it cannot run in non-stop from outlying suburbs, and unlike New York subways it can offer no express service, because each station along the route is a mandatory stop. Unlike the subways of Paris, Tokyo, or London, which are interconnected networks of lines, BART offers one route in each compass direction and hence only limited distribution across the urbanized area it serves.

Because of its misnomer and because it fits none of our stereotypes, BART has been befuddling its critics, who seem unable to categorize it tidily. The important fact is that BART was designed to meet the rather specific purposes enumerated above, and those purposes happen not to be the ones by which some critics have judged it, reflecting social concerns that were not widely shared when BART was designed. For example, it was never intended to serve the kinds of short-distance trips that local buses, trolley cars, and center-city subways serve. It was not designed to carry low-income persons from central-city homes to suburban factories, even though BART officials belatedly voiced such claims.

Rightly or wrongly, BART was designed to transport peak-hour commuters from suburbs to central business districts. In turn, it was intended to generate the following effects:

to reduce peak-hour highway traffic congestion,
to reduce time expended on commuter travel,
to foster central district growth,
to generate development of subcenters throughout its region,
to raise land values,

to accommodate suburbanization of residence and centralization of employment,
to reduce land area devoted to transportation facilities.

The expectations of some enthusiasts have sometimes been rather extreme, viewing BART as a remedy for whatever snake oil fails to cure. In turn they have generated a wave of criticism in both the popular and professional media that has often been comparably extreme. Such expectations and criticism are unreasonable. BART represents a serious response to perceived problems in regional development, planned with the advice of some of the world's most accomplished engineers and designers. Because it is the first of its kind and is now being watched so closely by officials in other cities around the world, and because it is so terribly expensive, we must soberly check whether the outcomes its planners expected are being realized. We have reviewed the studies completed to date in light of the objectives listed above, and we find the planners' predictions have, so far, been far from perfect. Now that history is catching up with forecast, it appears that history has been following a compass of its own.

BART's patronage

Prior to the 1962 bond election that authorized BART, the key informational document was the so-called *Composite Report*, published in May 1962.[2] Among the important expectations there were hopes 1) that BART would divert 48,000 workday autos from the streets and highways by 1975 and 2) that 258,500 daily passengers would be riding BART in 1975—157,400, or 61 per cent, diverted from automobiles, 39 per cent from existing transit systems.

Although 1975 has arrived and passed, it is not yet possible to submit those predictions to the definitive test, for BART was late in getting started, and thus has not yet developed a "seasoned" patronage. Moreover, the system has been so besieged by electronic and mechanical difficulties and rising costs that it is still not operating to design standards nor offering any weekend schedule. With these qualifications in mind, we can nevertheless compare the actual volumes being experienced with the predicted patronage.

The record of BART's average daily patronage is shown in Table I, which also indicates the forecasted levels. Some of the shortfall must reflect the chronically unreliable schedules and the associated long waiting times at stations, owing to equipment

TABLE I. *Forecast as Against Actual BART Patronage, June 1976*

Route Segment	Average Weekday Trips: 1961 Forecast for 1975	1976 Actual	Actual as Per Cent of Forecast
Transbay	77,850	53,880	69
East Bay	129,493	39,725	31
West Bay	51,153	37,765	74
Total	258,496	131,370	51

failings. Some of the shortfall must also reflect sheer deficiencies in prediction; the forecasters had little prior experience to base projections upon, because there had never been a BART-like system in this kind of metropolitan area or the analytic tools for forecasting the demand for this new product.

The Concord line into San Francisco is proving highly attractive, with peak-hour standees outnumbering seated passengers. When enough cars are available to provide seats for most riders, patronage will undoubtedly exceed current levels. Other lines are doing much less well, however, and the net effect is that *total patronage is running at about half of the initial expectations.* Instead of the 258,500 weekday passengers forecasted, only 131,400 were riding in June 1976. Peak-hour riders across the bay number 8,000, a little over one fourth of the designed capacity of transbay trains—28,800 seated passengers per hour.

There are several surprises in those figures, however. Although the *Composite Report* expected that 61 per cent of riders would be diverted from private automobiles, in fact *only 35 per cent formerly made the trip by car.* In response to a BART customer survey, about a fourth of the riders said they had not made the trip at all before BART began operating. However dramatic the apparent volume of newly generated travel may be, it actually represents only a small portion of new trips BART has triggered, for it has generated additional *auto* trips as well.

BART initially reduced the number of cars on the streets and highways by 14,000 (not 48,000, as forecast). In turn, in accordance with the Law of Traffic Congestion (which holds that traffic expands to fill the available highway space until just tolerable levels of congestion are reached), other people began driving their cars on trips they would not otherwise make. Perhaps they are suburban wives who now have the family car during working

hours. Perhaps people are visiting friends, now that highways are less crowded. Whoever they are, the net effect is an increase in the amount of sheer mobility within BART's region by both road and rail.

The best available data on these phenomena were recorded at two of the most severe congestion points in the region, at just the places BART was to provide congestion relief. The Bay Bridge is the most difficult transport corridor in the Bay Area, and the Berkeley Hills tunnels are also becoming major arteries as population continues to expand in Contra Costa County suburbs.

Figure II records modes of travel across the bay during recent years. The striking sudden rise in total travelers following the opening of BART's transbay tube reflects two other major events as well. The two-month-long strike of AC Transit bus drivers in 1974 caused a reduction in its patronage, and the strike ended just 16 days before BART's transbay service opened. In addition, 1974 was marked by those long waiting lines at gas stations, rising gas prices, and parallel reduction in auto use.

FIGURE II. *Annual Transbay Passengers, 1968-75 (Adjusted for Effects of Bus Strikes)*

Source: ITTE Traffic Surveys

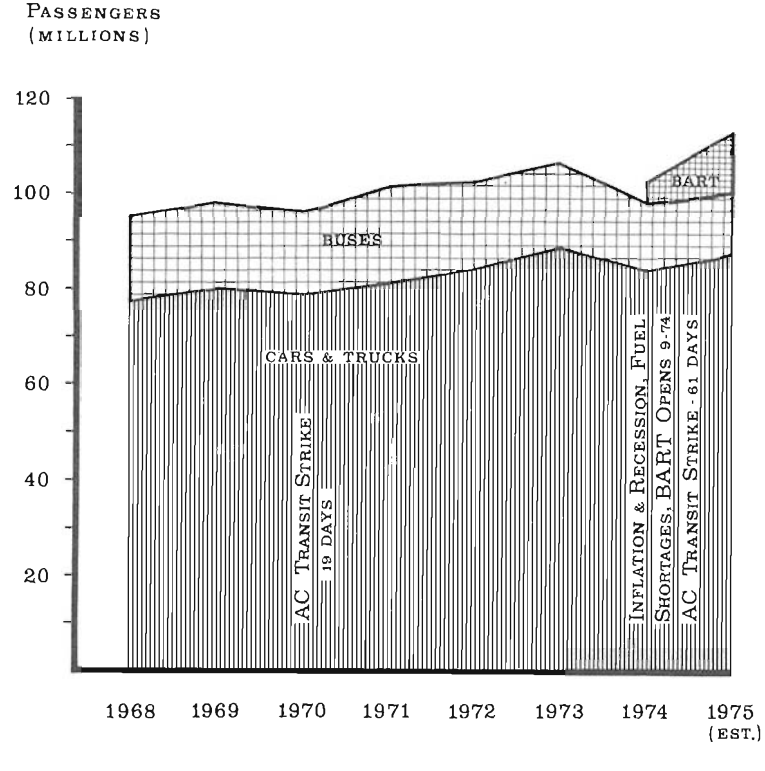
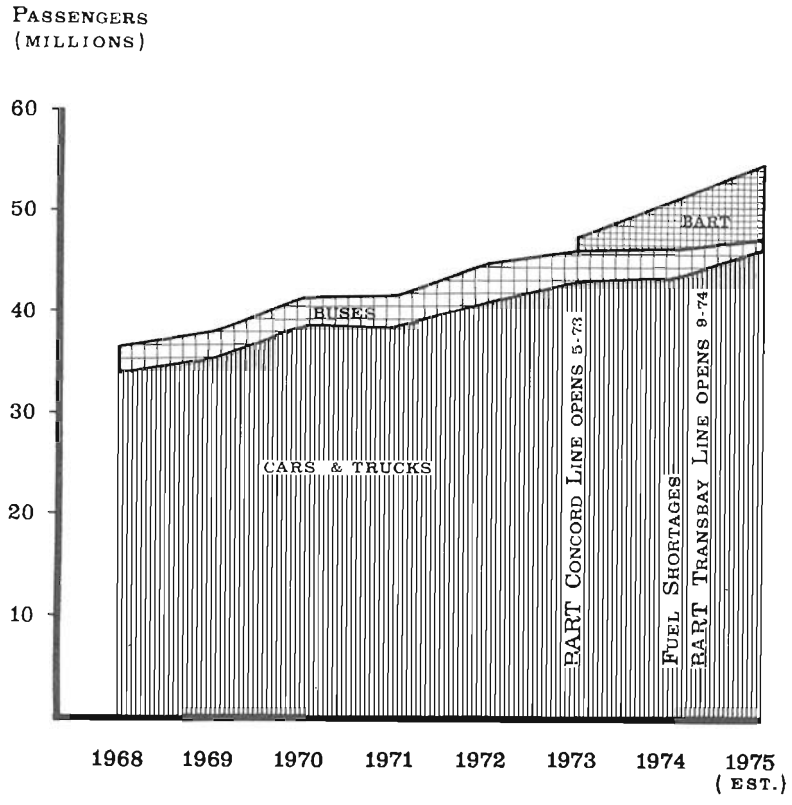


FIGURE III. *Annual Passengers Through Berkeley Hills Tunnels, 1968-75*

Source: California Division of Highways, Annual Traffic Census, ITTE Surveys



BART has brought about a rise in total transbay travel by both auto and public transit. Between 1973 and 1975, the proportion of daily transit riders on the bridge rose from 17 per cent to 22 per cent. Buses used to carry all 17 per cent; they are now down to 10 per cent, while BART is serving 12 per cent, a third of them in midday. During the peak hours, BART and buses split the transit passengers evenly, each carrying 50 per cent of them.

Half of all BART's transbay passengers formerly rode the bus. In contrast, those using *local* buses seem not to find BART as attractive, probably because of the wide station spacing. Indeed, even during the two-month transit strike, only 10 per cent of the East Bay bus riders used BART instead. Three fourths of all BART passengers travel over seven miles; half of them travel over 12 miles; a fourth over 19 miles! Clearly, BART is serving the long-distance travelers, as intended; but it is carrying only half as many travelers as intended.

The effect on highway traffic

BART's effects on auto traffic are a great disappointment. Although it has indeed attracted some 44,000 trips per day that used to be made in private cars, that is far fewer than the 157,000 forecasted. At most, the overall change in the three counties served may be a small net reduction in auto-traffic volume since BART began; but the change might also be a small net increase. The available regional data make either conclusion plausible.

There was a clear short-run reduction in auto traffic just when BART's transbay service began in September 1974, but BART may have had little to do with it. The gasoline shortage had just cut into auto use, and at the same time gas prices were rising to 60 per cent above their previous levels. Simultaneously, economic recession was increasing unemployment levels (up to 11 per cent in the Bay Area), while inflation was compelling many families to cut their spending levels and perhaps their automobile use.

Under those circumstances, we would normally expect reduced highway traffic volumes and, consequently, reduced congestion. In fact, traffic counters on the several Bay Area bridges do record a reduction in auto travel throughout the region in the period 1974-75. But the surprising fact is that the Bay Bridge, which parallels BART's transbay tube, experienced a smaller proportional reduction than any of the other bridges across San Francisco Bay. Auto travel on the bridge was sustained despite the inauguration of BART transbay service. Paradoxically, because so many commuters switched from buses to BART, the number of buses in the bridge traffic stream was reduced, thus creating more space for cars. Contrary to plan, even if only to that extent, BART has made it easier to commute by car.

It is clear that the enthusiastic expectations of dramatic reductions in auto volumes have not been realized. If BART is having any effects on overall vehicular traffic on the Bay Bridge, they are as yet so slight as to be undetectable, not exceeding two per cent or about one year's normal growth in traffic.

Pretty much the same picture emerges at the Berkeley Hills tunnels, where BART patronage has been high. The start of BART service in May 1973 was associated with a levelling of auto traffic volumes. However, a few months later traffic volumes rose again. They are now higher than ever in the auto tunnel that parallels BART's tunnel, and congestion tie-ups occur just about as frequently as they ever did.

California's Department of Transportation has made a serious attempt to measure BART's effects on highway congestion. On a few routes roughly paralleling BART's lines, peak-hour travel times were found to be reduced sharply when BART service began, demonstrating that even a few cars taken off a full freeway can convert sluggish traffic movement into a free-flowing traffic stream. It appears that where freeways ran at capacity levels, BART is making for appreciable improvement in travel times. However, the marginal autos that spell the difference between congestion and free movement are so few in number (even a two per cent reduction can be sufficient) that one cannot count on their continued diversion. On some tested routes, travel times have already crept up to pre-BART levels. On a few they were unchanged throughout the pre-BART and post-BART periods.

So the conclusions are unambiguous. 1) BART is serving large numbers of suburban commuters, as predicted. 2) People are traveling more, by both car and public transit, despite rising energy costs and undoubtedly as a direct result of the new travel capacity that BART has supplied. 3) Half of BART's transbay riders come from buses, which BART has replaced—at very high cost, as we shall see later on. 4) BART has not effected a significant change in automobile-use habits, so traffic volumes and road congestion are still at just about pre-BART levels, but will no doubt rise as auto use increases.

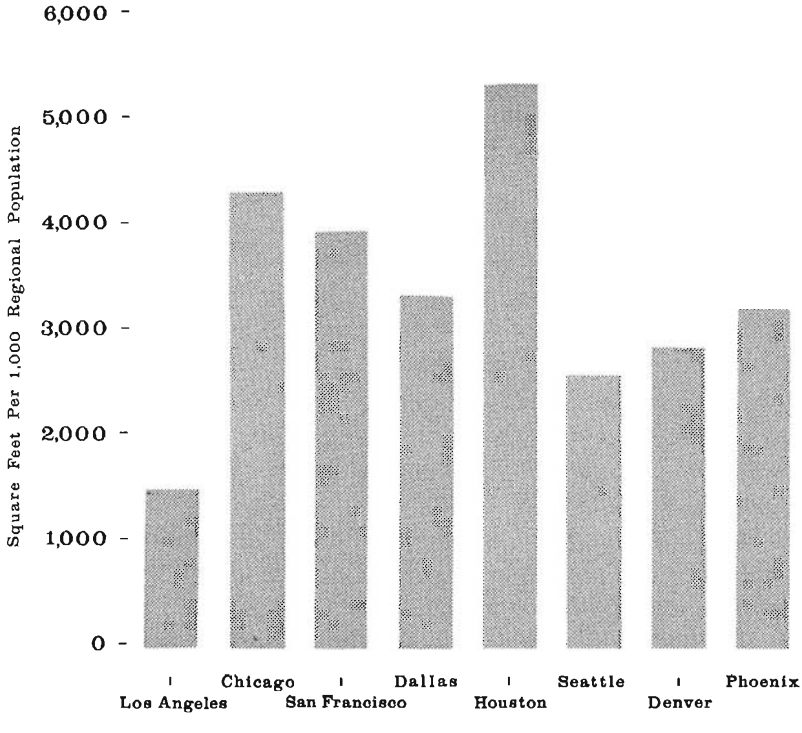
The effect on metropolitan development

During the 12-year period 1964-75, 35 high-rise office buildings were completed in San Francisco's central district, enclosing 18,500,000 square feet of floor space. During the next six years an additional 17 buildings are scheduled for completion, enclosing another 10,000,000 square feet. These are the structures that followed approval of BART's construction plan, each within an easy 10-minute walk of a BART subway station. Comprising 52 buildings and over 28 million square feet, they were the *cause célèbre* in the citizens' revolt against the "Manhattanization" of San Francisco, the joy of The City's regency, and the conundrum confronting transit planners elsewhere, who now wonder whether rapid-rail transit in their towns will trigger similar explosions. Whatever one's urban-design preferences—whether one loves or detests The City's new look—the question remains, what was BART's role in all that?

It is not clear to what extent BART caused the office boom, and to what extent the expected concentration of offices caused BART. Plausible explanations are obvious for either theory. BART officials like to claim credit for the spectacular change in San Francisco's skyline; they say it is a direct result of improved commuter access from the metropolitan region. However, they also argued from the outset that BART was primarily needed because forecasts of impending downtown office employment raised the specter of the ultimate traffic jam. The rub is that those forecasts were based explicitly on the assumption that BART would be built. If that reasoning were carried full circle, it should then be inferred that, without BART, there would be fewer offices concentrated downtown, less concentration of traffic downtown, more decentralized patterns of office employment, and hence no need for a BART-type system. Needless to say, that circle of reasoning is usually not closed.

FIGURE IV. *New High-Rise Office Buildings in Eight Western Metropolitan Centers, 1964-75* (Square Feet per 1,000 Persons in Metropolitan Region)*

*10 stories or more; region is metropolitan planning region as defined by local agencies



Large-scale office construction in other Western and Midwestern metropolitan centers suggests that the building boom might have happened anyway, for many of them have had similar booms, although none except Chicago has had anything like BART in sight. During the 12 years following BART's successful bond election, San Francisco's high-rise office buildings were expanded by 4,200 square feet for every 1,000 people in the metropolitan region. By contrast, Houston, the automobile city *par excellence,* added 5,500 square feet per 1,000 population, Chicago 4,500, and Dallas 3,500.

The past couple of decades have marked America's transition to the post-industrial service economy. Growing proportions of all jobs are in management and related services, new occupations that are conducted in offices rather than in factories. San Francisco has always been a center for the service occupations, and high proportions of firms coming to Northern California have traditionally sought locations in The City. Accelerating expansion of service activities during the 1950's, 1960's, and 1970's coincided nicely with the civic determination to renovate the city center. New office space was quickly filled, encouraging others to invest in rentable space; and they in turn found other waiting tenants within the growing services sector eager to be in the center of things. In effect, optimistic prophecies of blossoming central business activity became self-fulfilling. The more buildings that touched the skyline and the greater the subway-construction mess along Market Street, the more that companies wanted to be in on the action; and more engendered still more. Once the old-fashioned boom-town spirit spread, it became self-generating, building on its own image, enticing still more firms in search of the prestigious addresses, proving once again that nothing succeeds like success.

Surely BART was part of the generating force, for it was a massive piece of the big construction set. Skillfully crafted by the hands of a masterful executive director, its futuristic billing made it into the very symbol of enlightened civic enterprise, one more persuasive factor that would tilt a wavering business executive toward an office choice in The City.

There are no categorical answers to the conundrum about BART's role in San Francisco's reconstruction. I incline to the guess that it would have happened anyway, but that BART nonetheless made it happen bigger and quicker.

Is the story likely to be repeated elsewhere? Probably only in those cities having a comparable attraction for headquarters offices and ancillary business services. However, as the experiences of

Houston, Dallas, and Denver emphatically show, a BART-type rail system is not a necessary condition for a city building boom of this sort. Unquestionably, adequate transport services are essential, but effective transport comes in many other forms as well. Those other Western cities have been undergoing explosive central office-building expansion while relying on automobiles and buses. But for the promotional attraction of BART, San Francisco might have done as well with intelligent development of its own road transport system.

Suburban sputter

The initial plan for BART was also to generate growth at selected subcenters throughout the metropolitan region. In addition to the high average speed, that was the other rationale for widely spaced stations. The planners fully expected that increased accessibility at train stations would make the surrounding areas attractive to business firms and apartment dwellers, following the model of earlier commuter railroads in the East. In turn, clusters of offices, shops, and high-density housing around these stations would visibly restructure the region, stemming the drift toward low-density dispersion and urban sprawl.

It is now 14 years since the BART project was approved, and there is, as yet, little evidence to corroborate those forecasts and hopes. Most suburban stations stand in virtual isolation from urban-development activity in their subregions, seemingly ignored by all except commuters who park their cars in BART's extensive lots. A few apartment houses have been built within one-mile radii of a few stations, but they are exceptions. Two, modest-sized office buildings were erected, in Berkeley and Walnut Creek, close to the stations and as direct response to BART's coming. Although they were initially in trouble owing to BART's delayed opening, they now are reported to be occupied. In general, however, the transit stations have not attracted higher density suburban developments.

On the contrary, in a few places, Oakland's Rockridge neighborhood may be the most dramatic example, BART's coming has provoked citizen protests against potential high-density or commercial development. In turn, zoning regulations have been changed to prohibit apartment houses and shops, securing the established single-family housing pattern. The area surrounding the Rockridge station experienced an actual decline in property values when BART opened. Following the zoning change to one-family houses, land values have been rising, the highest being nearest to the station.

Unfortunately, other land-value information is still scarce, so that geographic shifts cannot yet be mapped against BART's routes and stations. The Rockridge case indicates that land values around stations will not inevitably rise. There is of course good reason to expect that values alongside elevated tracks may have declined, while prices in downtown San Francisco have probably been elevated by BART's arrival. However, whatever the shifts may turn out to be, land economists agree that rising values in one location will be about equally matched by declines elsewhere, rather as levels in an air mattress rise and fall as one section or another is squeezed or released. Unless the whole metropolitan economy has been caused to expand, the total of land values will remain essentially constant; and we have no evidence as yet of any effects, either negative or positive, that BART may have had on the total economy.

By being heavily subsidized and charging fares well under its actual costs, BART has appreciably reduced monetary commuting expenses for outlying suburbanites who work in the central cities. *Thus, rather than deterring suburban sprawl, BART may instead be encouraging it.* The unexpected popularity of its suburban Concord line clearly signals the response of suburbanites to the bargain rates being charged. We know of no explicit empirical evidence that BART is bringing about further suburban spread, but the parallel history of freeway-induced reductions in travel costs is unambiguous. Even though BART's land-use effects may not yet have been made manifest, the longer-run expectations should be clear. If BART is to influence the future course of suburban development at all, it seems as likely that it will be an agent in spreading suburban growth as in concentrating it.

Perhaps a basic flaw in the initial planning was the failure to take into account existing high-level (and virtually homogeneous) accessibility throughout the Bay Area. The ubiquitous network of streets, highways, and freeways, combined with extremely high auto availability, made for a context that scarcely resembled the 19th-century urban settings that earlier suburban railroads were fitted into. Bay Area residents move about within the metropolitan area with great freedom; they can go from virtually anywhere to anywhere else with only occasional delays, because the road network makes all points within the region highly accessible to all others.

When BART added additional accessibility on top of existing levels, it was proportionally only a small increment. Suburban and downtown stations are only slightly more accessible now than

before BART was installed, scarcely enough to have significantly affected the location plans of many households and firms. If the rail line had been the major access route, things would have been different. But overall accessibility in this road-rich metropolitan region has not been appreciably modified, and so neither have urban development patterns.

Land use and transportation systems are highly interdependent. BART's failure to attract many riders may also be contributing to its failure to attract building investors in the areas of its stations. Moreover, seeking to reduce land-purchase costs while encouraging the park-and-ride habit, BART designers located stations at some distance from established suburban business centers and then surrounded them with parking lots. As a result, potential developers are compelled to build outside easy walking distance, and so most go to the established centers instead. It is almost as though the right-of-way agents who purchased property and the engineers who located the stations were either oblivious or opposed to the objective of fostering suburban clustering. It is also reasonable to believe that land-use effects take a long time to become manifest, especially in an auto-oriented society, and that we shall therefore have to wait another 10 years or so before we will know whether BART will affect development at all.

Who rides and who pays

Everyone expected from the outset that BART would have to be bought with solely local funds. There were no other options at the time, for BART's planning preceded by a decade federal government financial support for transit. Indeed, it may be that BART's favorable publicity may have so popularized rail transit that in some degree BART is responsible for the availability of federal subsidy funds today. But at the time it was being designed, the Bay Area was on its own.

The plan was to draw upon the traditional source for local capital improvements, general obligation bonds secured by a property tax. Those were the bonds approved in November 1962—at that time, the largest local bonding referendum ever, amounting to $792 million. The fund was to be sufficient to pay the full costs of all the capital plant except the transbay tube and the rolling stock. The tube was to be built with tolls collected from bridge users. Rolling stock and all operating expenses were to be paid from fares collected from BART users.

Subsequently, when capital costs began to exceed initial estimates, it became necessary to find other resources. Among those explored were supplements to auto-license fees, higher bridge tolls, and general highway-improvement funds. These were forcibly opposed by those who disliked a direct tax on motorists. In the end, the 1969 state legislature authorized a $150 million bond issue, financed by a one-half of one per cent addition to the general sales tax within the three-county district that was to be served by BART.

These three sources of capital funds (property taxes, sales taxes, and bridge tolls) then still turned out to be insufficient, for there was not yet enough money to buy the cars. Fortunately, the federal transit grant program was initiated in time to permit BART to purchase its rolling stock (federal grants have by now amounted to $305 million), and a parallel state-aid program was initiated that now yields an annual subsidy (about $2.6 million this year).

The 1962 *Composite Report,* circulated prior to the public vote on the bonds, had presented a favorable estimate of operating revenues and costs for 1975-76. BART's own current financial reports now present a far more gloomy picture:

TABLE II. *BART Operating Revenues and Expenses (Fiscal Year 1975-76)*

	MILLIONS OF CURRENT DOLLARS:	
	1962 COMPOSITE REPORT	ACTUAL (PRELIMINARY)
Gross Fare and Concession Revenue	$24.5	$23.7
Operating Expense	13.5	64.0
Net	$11.0 surplus	$40.3 deficit

When it became apparent that fares would be insufficient to cover the costs of rolling stock and operations, the 1974 state legislature authorized, as emergency aid against the impending operating deficit, a temporary extension of the one-half of one per cent sales tax to be applied to the operating deficit. This yields about $28 million per year, enabling BART to continue operating until the latter part of 1976, by which time an extension or some other operating subsidy will be needed.

As of June 1976, the overall picture of BART expenditures and sources of funds looked like this:

TABLE III. *Sources of Funds for BART*

	MILLIONS OF CURRENT DOLLARS	PER CENT OF TOTAL
Capital Funds		
General Obligation Bonds	$792	50
Sales Tax Revenue Bonds	150	10
Toll Bridge Revenues (for Transbay Tube)	180	11
Federal Grants	305	19
Miscellaneous Revenues	159	10
Total	$1,586	100
Annual Operating Funds (1975-76 Estimates)		
Fares and Concession Revenue	$23.7	37
Sales Tax Revenue (0.5 per cent)	27.7	43
Property Tax Revenue (5¢ for Operations)	5.0	8
State Aid (0.25 per cent Sales Tax)	2.6	4
Federal Aid	.5	1
Borrowings Against Capital Account	4.5	7
Total	$64.0	100

Rationales for Funding Sources

It is apparent that a number of competing principles of taxation have been applied. The use of bridge tolls was in part a trade for additional traffic lanes acquired when the old interurban railway was removed from the bridge in 1958. Further rationalization could be based on the argument that motorists and truckers on the bridge would benefit from reduced traffic congestion, thus that they should contribute to the costs of creating the advantages they enjoy. A parallel view sees the transportation system as a whole, and then argues that the highway and rail subsystems should be funded from a common pool in the interest of a well-integrated overall system. In both contexts there is a rationale for earmarking bridge tolls for the transbay tube. The two arteries are substitutable for many trips, and the interaction effects means that both necessarily serve the same clienteles. A similar argument justifies using BART fares to cover its own operating costs and purchase of rolling stock. Since the benefits would redound directly to riders, it was argued that the riders should cover these costs.

Accordingly, the principle of directly charging beneficiaries is being applied to 11 per cent of the capital investment (paid by motorists) and 37 per cent of the operating-and-rolling stock budget (paid by BART riders). (In fact, however, federal government grants were used to buy most of the vehicles. Operating costs are nearly five times higher than expected, leaving insufficient resources with

which BART could buy the cars to operate.)

Funding for the balance of BART costs is justified against quite different principles of public finance. Rather than charging users and other direct beneficiaries of the system, these costs are being distributed among all sectors of the BART District's population and economy. Well over half of both capital costs and operating costs are currently being charged against general local taxes on property and/or retail sales.

One rationale for regional levies holds that the benefits are so diffused, it is virtually impossible to *find* the beneficiaries, much less to assess the benefits each enjoys. And, moreover, since BART's promoters saw it as a good thing for the entire three-county area, they argued that everyone in the three-county area should contribute to it. Although it might also have been argued that many of the benefits from the system are capitalized in property site values, thus possibly justifying a property tax, in fact the modes of taxation selected were simply those that were politically acceptable.

But even after the rule of universal contribution was accepted, the question remained, *how much* should each person contribute? That question was never frontally addressed. Instead, almost out of habit, the property and sales taxes became the sources of revenue. In concurring, the legislators thereby neglected two other principles of taxation, the one that relies on ability to pay as a test of equity and the one that instrumentally justifies taxes as means for making the transportation system work right.

TABLE IV. *Average Annual Incidence of BART Property and Sales Taxes on BART-Area Households, 1970**

	Average Annual Tax Per Household					
	Property Tax		Sales Tax		Total	
Household Income	Dollars	Per Cent of Income	Dollars	Per Cent of Income	Dollars	Per Cent of Income
Under $3,000	$17.30	.87%	10.00	.50%	$27.30	1.37%
$3,000-$4,999	18.60	.47	11.00	.28	29.60	.75
$5,000-$6,999	19.70	.33	13.00	.22	32.70	.55
$7,000-$9,999	22.50	.26	15.00	.18	37.50	.44
$10,000-$14,999	27.00	.22	18.00	.14	45.00	.36
$15,000-$24,999	33.60	.17	25.00	.13	58.60	.30
$25,000 and over	43.10	.13	30.00	.09	73.10	.21
BART Area Average						
$10,675	24.80	.23	16.00	.15	40.50	.38

*Based on 1970 Census. BART's annual rates of taxation in fiscal 1969-70 were $.531 per $100 of assessed value of property and .5 percent on taxable retail sales. The sales tax was initiated on April 1, 1970.

Over 60 per cent of capital costs and about 55 per cent of operating costs are being paid by all residents of the three-county district through taxes on property and retail sales, both inherently regressive modes of taxation. E. G. Hoachlander has estimated the incidences of BART's property and sales taxes and compared them with household incomes.[3] His findings indicate that both taxes fall proportionately far more heavily on households with low incomes than on wealthier ones.

There is a lively debate among economists concerning the degree to which property taxes are regressive, proportional, or progressive. Strong theoretic arguments are being made on both sides of the debate. One view holds that property taxes on commercial and industrial property are shifted forward to consumers. Because housing expenditures and other forms of consumption comprise larger proportions of poor families' incomes than of rich, a flat-rate tax falls proportionately more heavily on the poorer end of the income distribution, producing a regressive incidence. The counter theory claims that taxes on commercial and industrial property are taxes on capital and that they lower the rate of return to owners of capital. Because ownership of capital is more heavily concentrated among wealthier families, this view holds that property taxes are at least proportional and perhaps progressive. Moreover, some economists argue that this tendency toward progressivity is further reinforced by capitalization of taxes into house values. Prospective buyers will consider tax burdens prior to purchase, offering lower bids for more heavily taxed homes.

The degree of shifting of taxes on commercial, industrial, and rental property will be disputed for some time. Until the debates are resolved within the economics fraternity, the credibility of Hoachlander's conclusions will remain ambiguous. On the regressivity of the sales tax, however, there is more general agreement. The poor devote higher percentages of their incomes to consumption than do wealthier families, so that sales taxes are unquestionably regressive in incidence.

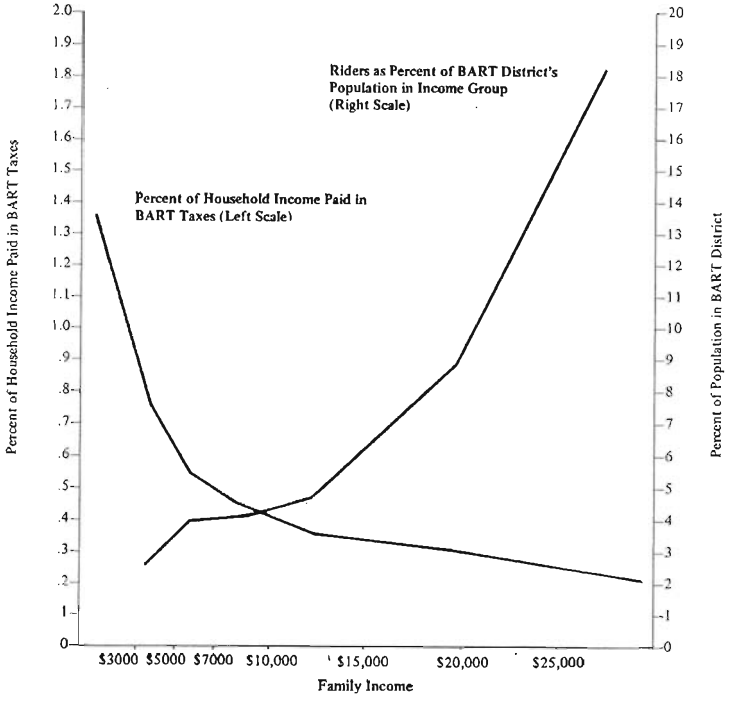
In an effort to keep track of customers' characteristics and preferences, BART has been conducting a periodic survey of its riders. The last completed survey was made in May 1975, eight months after transbay service started and two-and-a-half years after East Bay trains began running. The riders' own reports on their incomes reveal that they are not a representative sample of the Bay Area population. They are drawn far more heavily from the upper sectors of the income distribution than from the lower, reflecting,

TABLE V. *Incomes of BART Riders*

ANNUAL FAMILY INCOME	PER CENT DISTRIBUTION OF BART RIDERS	PER CENT DISTRIBUTION OF POPULATION IN BART DISTRICT	RIDERS AS PER CENT OF POPULATION IN BART DISTRICT IN INCOME GROUP
Under $5,000	10.5%	22.9%	2.62%
$5,000-$6,999	6.8	9.8	3.98
$7,000-$9,999	12.6	16.9	4.07
$10,000-$14,999	21.6	25.6	4.83
$15,000-$24,999	30.6	19.3	9.12
$25,000 and over	17.8	5.6	18.26
	100.0%	100.0%	

no doubt, the system's attractiveness to long-distance suburban commuters. The chart below compares the income distribution with the proportions of family incomes devoted to BART taxes. The ratio of these two curves is 40 to one: The percentage of income paid to provide tax support for each ride taken is 40 times greater for an individual in the lowest income group than for one in the highest income group. Clearly, the poor are paying and the rich are riding.

FIGURE V. *Income Comparison of BART Taxpayers and BART Riders*



Comparative costs

Every trip calls for three kinds of expenditures. There are the dollar costs that auto owners and transit agencies pay for vehicles, fuel, roadways, drivers' salaries, interest charges, insurance, and so on. There are the time expenditures made by travelers, who seem to make sensitive assessments of the lengths of time they must spend riding vehicles, getting to and from vehicles, and especially transferring and waiting for the next vehicles to arrive. The third kinds of costs are external to the transportation systems: annoyances borne by neighbors who must suffer noise, pollution, congestion, and other nuisances that transportation systems and their patrons impose.

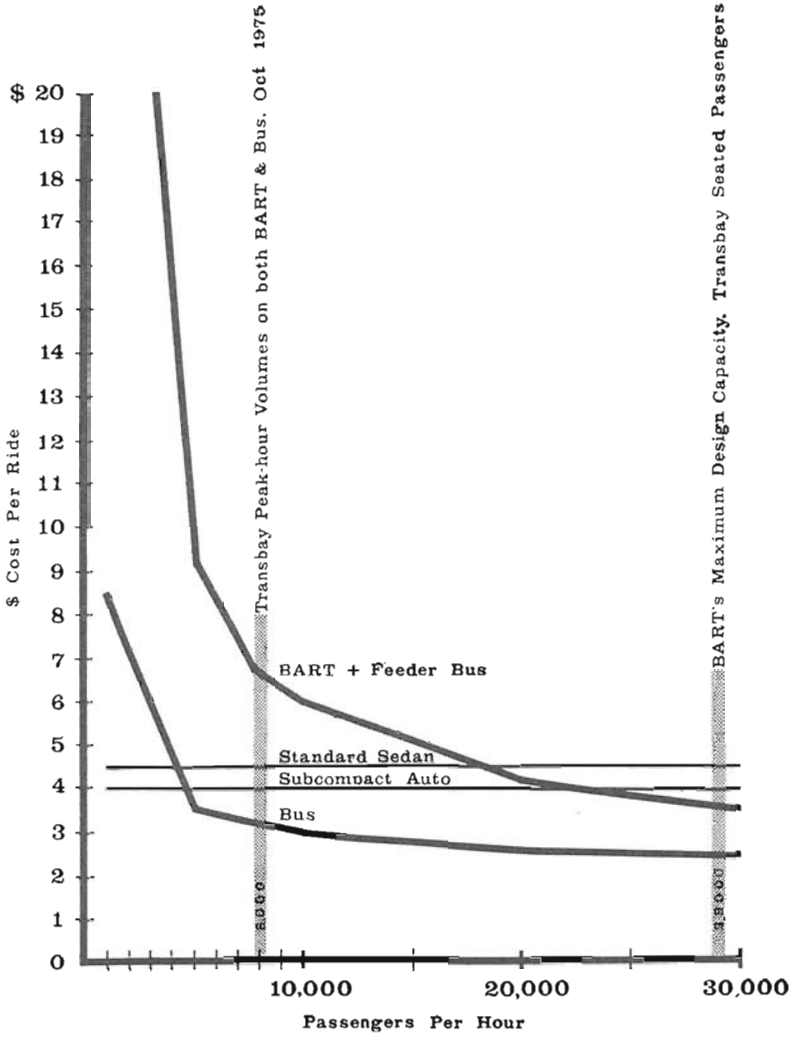
To compare the costs of alternative travel modes, one must tot up the monetary outlays, the time expenditures, and the social costs associated with each mode, preferably on standardized scales and in common coinage. This is obviously difficult to do, if only because each mode of travel provides somewhat different qualities of service and because some costs and some benefits are not directly traded in pecuniary terms. But it is not impossible to do.

A group of economists at Berkeley, led by Professors Theodore Keeler and Leonard Merewitz and Dr. Peter Fisher, recently completed a careful study aimed at comparing the full costs of standardized trips on BART, local buses, and private cars.[4] Their findings indicate that *the bus is consistently more cost-efficient than even a subcompact automobile, at virtually all levels of traffic density and at current averages of 1.5 persons per car.* No surprise there. But they also find that the bus is consistently cheaper than BART for comparable qualities of service, whichever set of technical assumptions is built into their estimating formulas. *Moreover, and to everyone's surprise, their findings show that a subcompact automobile is also cheaper than BART, except when travel densities approach 20,000 passengers per hour within a single traffic corridor.*

BART's maximum design capacity on the transbay and West Bay lines is 28,800 seated passengers per hour (72 passengers per car, 10-car trains spaced at 90-second intervals). So far BART has not approached that level of patronage. In Wolfgang Homburger's October 1975 survey, BART's maximum single-hour transbay load was 8,120 eastbound passengers at the height of the evening peak period. Instead of 28,800 passengers *per hour* in each direction, BART's transbay patronage was only *28,500 per day.*

Maximum design capacity on each of the three East Bay lines would be 14,400 seated passengers per hour if it were to achieve 3-minute headways. Presently, owing to persistent shortage of usable cars, it is averaging between 6- and 12-minute headways in the East Bay, with seating capacity under 3,600 and 7,200 per hour. These are different performance levels from those promised initially; they

FIGURE VI. *Full-Costs of a Transbay Ride: BART, Bus, and Auto; Peak-Hour Commuter Trip From Orinda to Montgomery Street, San Francisco (Low Estimates, Computed to be Most Favorable to BART)*



are scarcely the marks of a *mass* transit system with guaranteed seating for all passengers. They are particularly troubling, however, because BART's high capital costs require that it carry very large numbers of passengers so that the cost per rider can be maintained at a tolerable level.

Philip Viton has computed the full costs of carrying one passenger on a representative trip by BART, bus, and auto, as shown in the tables and charts on the following pages. Cost per ride appears along the vertical axis of the chart. The cost for a single transit passenger depends on the total number of passengers riding in a single corridor and thus sharing the capital costs of rail or roadway and the operating costs of fuel and so on. Corridor traffic volumes are arrayed along the horizontal axis; in these computations they are expressed as numbers of one-directional passengers in a single hour. The chart describes a transbay trip, apportioning the costs of the transbay tube and the Bay Bridge. Note that BART's efficiency as a *mass*-transit system is realized only when high volumes of patronage are achieved—in the region of 20,000 passengers per hour on each route. On the transbay and West Bay routes it is physically possible to carry those volumes because the three East Bay lines operate like branches serving the transbay trunk line. On the East Bay lines it is not physically possible to carry sufficient numbers of seated passengers to move into the low-cost regions of Figure VI. The Berkeley transport cost studies conclude that, *even when BART achieves its full design efficiency, it will still run at higher costs per passenger trip than buses on all its lines; and it may continue to cost more than an automobile even then.*

The estimates are based on assumptions most favorable to rapid transit. They assume a hypothetically optimized system in which schedules of buses and trains minimize riders' waiting time and agencies' operating costs. Estimates for automobiles include governmental costs of building, maintaining, and policing highways, individuals' total costs of buying and operating private cars, and the external costs of pollution. For each mode, a concerted effort has been made to account for all monetary and non-monetary costs borne by governments, travelers, and neighbors.

The dollar-equivalent costs are estimated against a set of variables related to interest rates on investments, value of travelers' time while riding, value of their time while getting to a train or bus, and the average lengths of trips. BART trip-cost estimates are highly sensitive to variations in interest rates, because of the large capital investment; and they compare best against bus and

car when computed for long-distance trips. As we shall see, because very few Bay Area commuters live within an easy walk of a BART station, BART trip-cost estimates are particularly sensitive to assumptions about the value of the access time.

There is some disagreement among economists on the dollar values to be assigned to passengers' time, but all agree that some dollar equivalents must be included in estimating total costs. After all, BART did go to great expense to offer high speeds, presumably because its designers believed that passengers value their time, preferring a brief trip to an extended one. Similarly bus operators work for short headways and for on-schedule performance because they believe that passengers' dollar-clocks click fastest when they are waiting for a bus to come. (If those beliefs were in error, the appropriate response would be to slow down the trains and to delay the buses. Obviously those strategies would be absurd.) The consensus among students of "modal choice" is that average passengers clock their walking-and-waiting time about three times more heavily than their riding time.

In an effort to avoid any inferences of negative bias, the estimates presented here have been deliberately biased in favor of BART. Throughout, wherever the estimating equations permit a choice of values, we have selected the combination of permissible variations to show BART trip-costs at their lowest levels when compared with the bus and the car.

The comparisons in Table VI present the full costs of carrying a hypothetical commuter 15.7 miles across the Bay from Orinda to San Francisco's Montgomery Street in the morning peak hour. We assume that he lives two miles from the BART station, which he reaches by a local feeder bus, and that he walks a quarter-mile from the Montgomery Street station to his office. Alternatively in

TABLE VI. *Full Costs of Peak-Hour Trip from Orinda to Montgomery Street*[1]

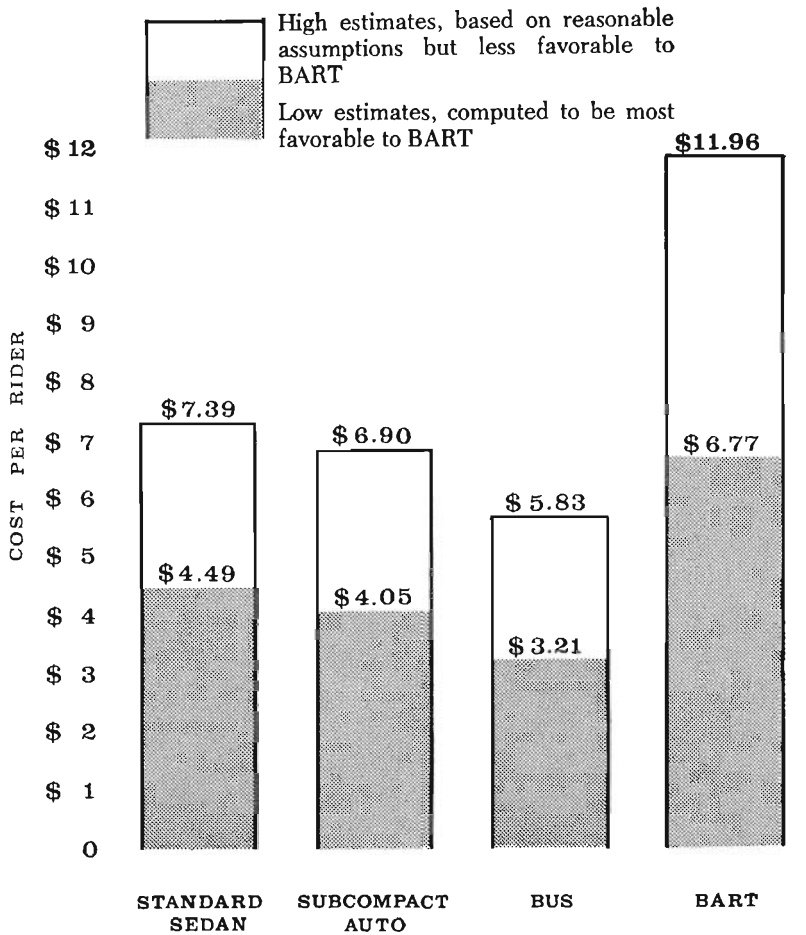
NUMBER OF PASSENGERS IN PEAK HOUR	AUTO		BUS	BART PLUS FEEDER BUS
	STANDARD	SUBCOMPACT		
1,000	$4.49	$4.05	$8.51	$34.08
5,000	4.49	4.05	3.72	9.20
8,000[2]	*4.49*	*4.05*	*3.21*	*6.77*
10,000	4.49	4.05	2.99	5.99
20,000	4.49	4.05	2.59	4.26
30,000	4.49	4.05	2.44	3.64

[1] In 1972 dollars. These are low estimates, computed to be most favorable to BART. Costs to agency plus time costs to riders plus social costs to neighbors.
[2] Current peak volume on both bus and BART.

our example, he could ride a bus from near his home to the Montgomery Street BART station, or he could drive his car and park in a public garage near his office.

Actual peak-hour volumes on the transbay routes for both bus and BART are only about 8,000 passengers per hour. At that volume, a bus ride costs $3.21 and a BART ride costs $6.77, with private cars in between. We have also computed estimates under less favorable, but nevertheless reasonable, assumptions concerning the value of commuters' time and the rate of interest on capital invested. For that same ride from Orinda to Montgomery Street at present peak-hour patronage, full costs would then be $5.83 on the bus and $11.96 on BART.

FIGURE VII. *Costs of a Transbay Trip on BART, Bus, and Auto; 8,000 Trips per Hour, October 1975; Peak-Hour Trip from Orinda to Montgomery Street*



When BART has been finally debugged and operates at full schedule and full efficiency, with a fully seasoned patronage, it will surely be carrying more riders; and so both average and marginal costs will then fall. The most favorable estimate for seasoned operation on that same commuter trip from Orinda to Montgomery Street is unlikely to fall below $6.00, however. (The less favorable, but still reasonable estimate is $10.00 for that trip.) In contrast, the full cost of a nearly equivalent ride on a bus would be between $3.00 and $5.00, and the cost of driving a standard sedan would be between $4.50 and $7.50, all costs included. Under those circumstances, BART is unlikely ever to replace other modes of travel, so long as travelers are permitted free choice. Perhaps only under regulated market conditions, imposing mandatory constraints on use of buses and cars, might BART carry the volumes of passengers that were forecasted for it.

The financial picture

All estimates above are economic costs—i.e., they reflect costs to the economy, representing the opportunity costs of using resources for these purposes rather than some others.

Alternatively, we might examine accountant costs—i.e., the costs as they might be seen by BART's internal bookkeepers. That picture is somewhat different. Annualizing BART's total capital costs to find its annual "mortgage payments" at its favorable 4.14 per cent interest rate, adding in its current operating costs, then dividing by annual passengers carried, the cost per trip comes to be about $4.48. With fares averaging around 72¢, the average subsidy then comes to about $3.76 per ride.

Two major factors are of interest here to officials in other cities. First, direct costs to the BART district are high because the system was financed largely from local sources. With federal subsidies now available, no other metropolitan area will finance a transit expansion on its own again. Second, BART's capital-intensive plant

TABLE VII. *BART's Annual Expense and Patronage Account (Fiscal Year 1975-76)*

ITEM	AMOUNT
Annualized Capital Costs	$ 82,400,000
Annual Operating Cost	64,000,000
Total Cost for Year	$146,400,000
Number of Trips during Year	32,700,000
Average Cost per Trip	$4.48

makes it inherently expensive. Subways and elevated, exclusive, grade-separated rights-of-way cost a lot, no matter how crudely or elegantly they are constructed. Besides, BART spent a great deal of money in pioneering research and development for new systems, the benefits of which will now accrue to other cities that build subsequently. But BART had one advantage over all other descendent systems. It was built with pre-inflation dollars. However exorbitant its costs may seem, they appear cheap relative to comparable systems under construction in Washington and Atlanta.

Rail-transit systems are inherently capital-intensive. When they are also burdened with very high labor costs, as BART is, operating expenses may become excessive. BART's operating costs are running at about 15.7¢ per passenger mile, while the local bus system is costing about 13.6¢. Despite the all-out effort to reduce manpower requirements by automating train operations and assigning only one attendant per train, BART now finds itself with a wage bill only slightly less than that of the local bus system—10.5¢ per passenger mile compared to about 13.2¢ for the bus. In part because of a federal requirement that led to a costly union contract and in part because of the high-priced engineering and planning staff it maintains, BART has not yet shown how to cut the labor and operating costs that have been hurting public transit systems of late.

As a result, it has been in a virtually continuous financial crisis. Governments can continue to "throw more money at it," but the real solution is for BART to attract sufficient patronage at least to carry its operating costs, as planned. The question, then, is why haven't Bay Area travelers been flocking to this outstanding transportation system.

What went wrong?

BART was designed to be a superior way for Bay Area commuters to get to work. Its promoters believed that if only superb transit service were offered, commuters would gladly give up their private cars. Because commuters are not responding as expected, it is important that we understand why.

The clue may lie in the few, but key design decisions that were made in the early stages of BART planning and that then fixed the system's essential character. It now appears in retrospect that those design features preordained BART's failure to lure the motorist.

At the time BART's designs were being drawn, the postwar auto boom was a major factor in metropolitan growth, and freeways

were accorded high priority. At the same time, public transit systems were falling into disrepair or being abandoned, and patronage was declining everywhere, projecting the prospect of a virtually all-auto transportation system. BART was seen as a lower-cost alternative to freeways and as a means for both reversing the trend and preserving the option of public transit. The design strategy was to top the automobile by producing a transit system that would incorporate and improve upon the automobile's most attractive features, thus making the transit system more than competitive.

The designers concluded that high speed, high comfort, high style, and downtown delivery were the attributes that matter most to motorists; and BART was then designed to outdo the car on those four counts. BART's management has delivered the system promised in its original specifications. Unfortunately, however, these may not be the features that will entice mass patronage.

The emphasis on high speed between stops and on comfort and overall aesthetic excellence quickly led to the decision to build a rail system, and that in turn led to a logically necessary network of decisions concerning equipment design, electronic control gear, roadbed standards, station qualities, and the like. As Randall Pozdena has insightfully noted, each of these decisions was simultaneously a decision to trade off other potentially desired qualities. Some of the more important sacrifices and compromises he identifies are in Table VIII below.

Of course every design for a complex system must make these sorts of trade-offs, for it is seldom possible to enjoy all advantages simultaneously. It is the tragedy of the BART story, however, that the chosen attributes compelled the sacrifice of features that were essential for attracting riders. Most important by far are the first four in the table. By choosing mainline rail, the designers created a system geometry that puts BART out of walking distance of most residents.

The designers seem to have been most concerned with the attractiveness of the BART system as seen by passengers after they arrive at the station. Station decor is handsome; waiting time for trains was to have averaged a brief 45 seconds; 80-miles-per-hour speeds make for short elapsed time en route; and the station at the other end of the trip is also aesthetically pleasing. But outside BART's premises, the passengers are on their own. They must find their way to the station by bus, car, or foot, make the transfer, and then find their way at the other end after leaving the BART station. While they are BART's guests they are treated very well; outside the premises they are rather neglected.

TABLE VIII. *Design Trade-offs and Compromises*

SELECTED QUALITIES	SACRIFICED OR COMPROMISED QUALITIES
1. High average speed between stations, therefore widely spaced stations.	1. Closely spaced stations, therefore ease of access to stations.
2. Mainline system serving major traffic corridors.	2. Network of transit lines serving sub-areas of the region. Ability to complete trip in a single vehicle without having to transfer to and from feeder system.
3. Batch-type transport mode: cars in trains carrying many passengers.	3. Flow-type transport mode: smaller vehicles carrying comparable numbers of passengers at shorter headways, with branching local distribution at origin and destination.
4. Fixed rail on exclusive grade-separated right-of-way.	4. Flexible routing in response to changing travel patterns. Economy of construction. Right-of-way usable by other vehicles. Disabled vehicles do not disrupt operation of entire line.
5. Limited number of access points into system, to encourage clustered urban development.	5. Compatibility with footloose trends and low-density settlement patterns.
6. Frequent service with stops at all stations.	6. Differentiated service with both "local" and "express" operations.
7. High aesthetic and comfort standards.	7. Economy of construction.
8. Regional long-haul design.	8. Local trip-making capability.

Oddly enough, although the designers have always been explicit about the critical role of bus access to the system, the planning process was rather nonchalant about creating it. There was little effective planning for feeder-bus service until the period just preceding opening day, and it is still quite inadequate in the outlying suburbs.

Making the wrong choices

During the past 15 years, at least a dozen major studies have investigated the ways travelers assess costs when deciding how they will make intrametropolitan trips. With remarkably small variation among the cities examined, the studies all conclude that *the time*

spent inside vehicles is judged to be far less onerous than the time spent walking, waiting, and transferring, by a factor of up to 3 or 4 times. For commuters waiting on platforms, the factor may be as high as 10 times!

BART designers were obviously unaware of these findings; the research was conducted after the key BART decisions were made. Indeed, their own understanding was just the opposite, as this key conclusion of the 1956 basic design report indicates:

> . . . interurban rapid transit must be conceived as providing only *arterial* or *trunk-line* connections between the major urban concentrations of the region. . . . We are convinced that the interurban traveler, facing the choice between using his private automobile or using mass transportation, will be influenced in his choice more by the speed and frequency of interurban transit service than by the distance he must travel in his own car or by local transit to reach the nearest rapid transit station.[5]

Herein may lie a clue as to why their strategy erred. Their fixation on high speed meant that riders spend relatively short amounts of time in BART's vehicles, but this is the kind of time that travelers place a low cost upon. That fixation has also inevitably meant long access times, which travelers account as a high cost. The desire for high speed led to wide spacing between stations, and that, combined with the skeletal mainline-route pattern, compels most travelers to use some kind of feeder service getting from home to BART. The use of a feeder bus compounds the onus of waiting and transferring, and many potential BART patrons have therefore simply decided to ride the bus all the way through to their destinations, instead of making the transfer. Many others have simply decided to continue driving their cars. The reasons for both decisions should now be clear.

Buses and cars mixed into the traffic stream operate at slower speeds than 80-mile-per-hour trains, of course. However, trains must stop at each station every 2.5 miles or so. Meanwhile buses and cars on freeways usually move along nonstop until they reach the terminal or exit. The net effect is that *scheduled running times for some East Bay peak-hour express buses to San Francisco are just about the same as for BART trains.* Of course, whenever an accident or a breakdown clogs the freeway, traffic slows down or stops; but BART's frequent breakdowns almost even the score. Overall, where express bus service is available, the advantages of no-transfer rides and steady freeway movement make the bus competitive in route time.

The major competitive advantage of buses, however, derives from the savings they permit in access time. Buses have the capacity to thread into residential districts, collecting passengers near their homes. Automobiles do even better than that, parked in the owner's garage and available at his call. Whatever the cost of traffic congestion, access time is zero. However unpleasant the bus may be, access time is low. In these respects, the bus and the car are functional opposites of BART; they trade off high speeds en route in in favor of easy access.

Anecdotal evidence on the relative valuation of trip attributes comes from several attitude surveys. One survey asked current BART, bus, and auto tripmakers to evaluate factors affecting responses to BART. In general, factors of comfort, privacy, seat availability, and other "luxury" aspects of the BART system were rated least important by transbay travelers who did not use BART, whereas total travel time and waiting time were their most important reasons for not using BART.

Dr. Michael Johnson, University of California, Berkeley, later asked a sample of Bay Area commuters why they did not use BART. Although the sample selected only persons who both live near BART and work in either San Francisco, Oakland, or Berkeley, 59 per cent said it was "impossible" for them to go to work on BART; and, of these, 86 per cent gave as the reason that BART is too far from home or job. Others reported that travel time was too great (16 per cent) or that transferring was bothersome (14 per cent) or simply that BART was "inconvenient" (10 per cent). That same survey indicates the automobile is favored because it is dependable, flexible, and fastest overall, while both BART and the bus are downgraded on those same attributes.

Professor Daniel McFadden at Berkeley has conducted intensive interviews with representative samples of Bay Area residents, seeking to uncover the reasons people choose trains, buses, or cars. His findings confirm the research by others with respect to travelers' weightings of access time and in-vehicle time. But then he also finds, surprisingly, that Bay Area transit riders seem to enjoy or detest spending their time in buses and BART trains just about equally. Despite the greater comfort and smooth ride that BART offers, he finds he cannot yet reject the hypothesis that travelers would just as soon ride the bus—time costs and money costs being equal.

Of course, it must be remembered that BART is still not fully operational. Frequent breakdowns of equipment mean that passengers are left waiting for extended periods on station platforms. Schedules have yet to approach the promised two-minute headways,

much less the promised 90 seconds. Until Thanksgiving 1975, trains stopped at 8 pm; and they are still closed down completely on weekends. On the most popular line, peak-hour standees outnumber seated passengers, owing in part to equipment shortages. Some suburban areas are still wholly without feeder bus service and others have highly inadequate service. Parking lots at stations are turning out to be far from sufficient to meet demands of park-and-ride patrons. When these problems are solved, as they surely will be, some patrons of buses and cars will become BART regulars.

It is difficult to estimate how many might make the switch. The crucial factor seems to lie not in those current failures of BART operations that have received such widespread press coverage. Repair or replacement of motors, train-control equipment, brakes, computers, and so on will permit BART trains to run on time. But trains will still be relatively inaccessible to most riders' origins and destinations. Even when all BART's mechanical and electronic problems have been solved, BART's basic design error will persist.

It seems that BART's mistake was made at the outset, when the wrong technology was chosen. Instead of lavishing primary attention on in-vehicle travel time and physical amenities, which called for a mainline rail system on an exclusive grade-separated right-of-way, the designers would have attracted more riders by adopting more automobile-like technology. A system that could pick up passengers within a short walk of their homes and deliver them, in the same vehicle, to within a short walk of their jobs would have been far more likely to entice them out of private cars. The success of both the new Golden Gate buses from Marin County to San Francisco and the express buses from the East Bay suggest that high-quality bus service can attract significant numbers of commuters.

It is the door-to-door, no-wait, no-transfer features of the automobile that, by eliminating access time, make private cars so attractive to commuters—not its top speed. BART offers just the opposite set of features to the commuting motorist, sacrificing just those ones he values most. This was a fundamental mistake. Given commuters' propensities to weight system access and waiting time so heavily and to place much less importance on in-vehicle time, it is scarcely any wonder that BART has not lured them away.

Moreover, the error is compounded by the high construction and operating costs compelled by the insistence upon high speed. That initial standard in turn determined much of the overall and detailed designs: a new and separated guideway, automatic controls, unconventionally wide-gauge rails, a highly stable roadbed, light-

weight cars of unprecedented design, a highly specialized and high-priced work force, and so on. If its stations were more closely spaced, if its routes were more extensive, if it were not so difficult to get to it, BART's patronage would certainly be far higher. The paradox is that potential passengers are not using it because it is too rapid.

Was it worth it?

Having spent $1.6 billion to avert the trend to the auto-highway system, BART is now serving a mere two per cent of all trips made within the three-county district, and about five per cent of peak-hour trips. Some 50,000 of its daily passengers have been diverted from inexpensive buses to expensive trains, 46,000 from private cars and car pools, and several thousand more from the latent pool of trips not previously made. The overall effect has been to leave highway congestion levels just about where they would have been anyway. BART may have been influential in propagating downtown building construction, but it has not yet had any visible effect on suburban development.

The most notable fact about BART is that it is extraordinarily costly. It has turned out to be far more expensive than anyone expected, and far more costly than is usually understood. High capital costs (about 150 per cent of forecast) plus high operating costs (about 475 per cent of forecast) are being compounded by low patronage (50 per cent of forecast) to make for average costs per ride that are twice as high as the bus and 50 per cent greater than a standard American car. With fares producing only about a third of the agency's out-of-pocket costs, riders are getting a greater transportation bargain than even bus and auto subsidies offer; and yet only half the expected numbers are riding. The comparative full costs of a typical transbay peak-hour commuter trip on BART are about $6.80, on a bus $3.25 and in a small car $4.00 —computing all those estimates with variables that make BART appear most competitive. The total economic costs of even a large-sized American car are still lower than BART's for a transbay commuter trip—all-day parking charges, highway construction, pollution, and all other measurable costs included.

The 50,000 passengers BART has diverted from buses could be carried in brand new luxury buses at a total capital investment of under $13 million. The BART system cost $1,600 million. The costs of buying a whole fleet of new buses sufficient to carry all BART's

passengers projected to 1980 would be under $40 million, or about half of one year's worth of BART's annual mortgage payment alone. One is compelled to ask, was it worth it? Was it wise to have built so costly a system?

Rather than reverting to pre-auto technology, the designers might instead have sought a competitor to the automobile that, by incorporating similar service capabilities, might then be more likely to induce commuters to switch. Among currently available alternatives are express buses that collect passengers near their homes, or subscription buses that pick them up at their doors, then use urban freeways to speed them to job centers; jitneys and group taxis, the major transit modes in many parts of the world, which use automobiles as public transit vehicles, interlacing residential districts and delivering directly to employment places; and franchised van pools that operate as a quasi-bus and quasi-car pool, providing door-to-door service at both ends of commuters' trips, albeit with some rigidity in scheduling.

These are automobile-like modes that more nearly approximate the door-to-door, no-transfer, flexible-routing features of the private car than do 10-car trains on fixed mainline rails. Although they all surely lack the high technological glamour of BART-like systems, they can approximate BART's in-route speeds; they can greatly reduce system-access time; and furthermore, as Professor McFadden's surveys in the Bay Area indicate, where time and money costs are equal, most travelers seem not to be taken by the glamour of BART over the bus anyway. In any case, with the ratio of capital costs between BART and buses on the order of 40 to one, and with operating costs per passenger-mile essentially the same, it would seem that investment prudence is therefore on the side of the express bus.

Experience with express bus service is still rather sparse, however; and so we can have no assurance that the high levels of transit patronage that BART was aiming for are attainable with buses either. Although we do now know that express buses work, we do not know whether they work well enough. Much more experimentation with various sorts of auto-like and bus-like modes is called for, including experiments with pricing schemes that charge motorists and transit riders the full costs of travel.

There are surely many who still believe that BART will eventually make it—that only start-up problems, overly publicized equipment failures, and annoying delays dissuaded potential patrons. Given enough time, they believe, BART's trains will run on time and will then become the powerful magnets capable of attracting

motorists at last. Given the uncertainties that bedevil this business, they might of course be right; only the test of time can tell. But even if BART were today carrying all 258,500 daily passengers originally projected for 1975, at present average fares it would be earning only $46,000,000 per year, or less than three-fourths of its *present* operating costs.

The power of promotion

If BART has achieved any sort of unquestionable success, it is as a public relations enterprise. BART has projected a superb image from the start: a high-speed, futuristic transport mode that would transport commuters in luxurious comfort without economic pain. It became one of the more effective signs of the Bay Area's avant-garde spirit, the very symbol of Progress.

As a result, it may be that BART's most successful effects have been felt outside the Bay Area. Urbanists and civic officials throughout the world have become intimately familiar with its promises. Many, in turn, have been encouraged to propose various sorts of modern rail systems for their own cities, some of them aided by the same consultants who mothered BART through its Bay Area gestation. Despite its problems, BART has both popularized and legitimized modern rail transit, and that much-reproduced photograph of the BART lead car has become a heraldic symbol on rail-promotion banners everywhere.

Back home in the Bay Area, the picture is rather more gloomy. Half the expected riders have chosen the convenience of their private cars or the local bus that also runs them close to their jobs. Real estate developers seem to believe that auto access is more important for their potential customers or tenants, and so they have pretty much ignored the locational opportunities BART stations opened to them. People quietly pay property and sales taxes, unable to do anything much about the BART levies, whether they like them or not, whether they benefit from them or not. Governmental officials, caught with a large investment, outstanding bonds, and rapidly rising operating costs, keep priming BART with the hope that it will eventually run on its own. According to one careful student of BART's finances, they would find it more cost-effective to abandon the train service and convert the rights-of-way into exclusive bus lanes instead. It is unlikely that any public officials will find that politically acceptable, however, especially when BART is still so new. Besides, public officials seem to be constitutionally incapable of admitting error.

The whole affair again raises some persistent questions about the analytical and ideological bases underlying local political decisions, about the locus of accountability, and about governmental capacity for learning. From the beginning, BART's planners were handicapped, because the state of transport-choice theory was so inadequate that it was impossible to simulate accurately what would happen if BART were built. They did not even have adequate descriptive data showing how people choose among travel modes, especially travelers having choices among three such first-rate systems as are now offered in the Bay Area. It was therefore virtually impossible to forecast patronage or revenues with any precision. The science of transport planning has simply been inadequate to warrant the level of confidence that has accompanied this project. However cautious the disclaimers that were attached to the forecasts, once in print the numbers somehow became reified, then accepted as facts by political leaders, voters, and bond buyers. One wonders to what degree ideological leanings affected personal beliefs when the forecasts were inherently so uncertain.

BART is the manifestation of a wide array of ideologies that must have made it attractive to a wide array of publics. It symbolizes the frontiers of science and technology and, simultaneously, the nostalgic old railways of the elder stateman's youth. It is the rationally efficient means for reducing land consumption, and it simultaneously reflects the romantic desire to capture the ethos of Parisian urban life. It is seen as sound business by both merchants and city officials, and as the instrument of sound development policy by city planners. It is the darling of the anti-auto, anti-technology ideologues and also of the engineers who admire its technological sophistication. Many people believed in BART for many reasons. The mere failure to meet its objectives is not likely to shake such faith, particularly when the appraisal is made in merely pecuniary terms.

Many are wholly pleased with the BART system. It offers perhaps the smoothest and quietest ride in the world. The cars and stations are physically handsome and pleasant. Fares are low and travel speeds are high. Save for the initial equipment failures, it is almost exactly the physical system that was promised to the 1962 voters. For those who can use it conveniently, it is superb. For others, the very fact that it was built is itself an achievement, for BART was surely one of the more spectacular civic projects, and the transbay tube one of the more daring engineering feats of our time. From those special perspectives, BART has been an unqualified success.

But the question remains whether leaders in other metropolitan areas can learn from BART's experience that these perspectives are illusory. Having been built in a metropolitan area offering what are probably the best test conditions in the country, BART is not passing the most important of those tests. It is struggling with persistent fiscal crises, with no prospect of ever becoming the self-supporting system the voters were promised. The poor continue to pay and the rich to ride, with no visible prospect that this will change. Its patronage remains low despite low fares and rising gasoline prices, and that situation seems to be stable too. Save for the possible influence on downtown San Francisco and Oakland, it has had few detectable effects on urban development patterns, and its effects on traffic congestion are similarly undetectable. Clearly, BART has not earned a passing grade on the significant tests. One wonders, then, what underlies the professional confidence of transit consultants, and what sorts of politics and ideologies in local and federal governments continue to promote BART-like systems elsewhere.

BART has been heralded as pacesetter for transit systems throughout the world. The evidence so far suggests that it may also become the first of a series of multi-billion-dollar mistakes scattered from one end of the continent to the other.

But in the long run, say in 50 years when the bonds will have been retired, when everyone will regard BART as just another built-in feature of the region, rather like Golden Gate Park, perhaps no one will question whether BART should have been either built or abandoned. It will then be regarded as a handy thing to have, a valuable facilitator of trips that would not otherwise be made by the elderly and the young, a blessing that enriches the quality of Bay Area life. And who will gainsay then the wisdom of having built a white elephant today?

NOTES

[1] The proposal was presented in Parsons, Brinckerhoff, Hall, and Macdonald, *Regional Rapid Transit,* Report to the San Francisco Bay Area Rapid Transit Commission (January 1956).

[2] Parsons, Brinckerhoff, Tudor, Bechtel; Smith, Barney, and Company; Stone and Youngberg; and Van Beuren Stanbery; *The Composite Report, Bay Area Rapid Transit,* Reports submitted to the San Francisco Bay Area Rapid Transit District (May 1962).

[3] E. Gareth Hoachlander, *Bay Area Rapid Transit: Who Pays and Who Benefits?* (Berkeley, University of California, Institute of Urban and Regional Development, 1976).

[4] Theodore E. Keeler, Leonard A. Merewitz, and Peter M.J. Fisher, *The Full Costs of Urban Transport,* three volumes (1975); Randall J. Pozdena, *A Methodology for Selecting Urban Transportation Projects* (1975); and Philip A. Viton, *Notes on the Costs of Mass Transit in the Bay Area* (Berkeley, University of California, Institute of Urban and Regional Development, 1976).

[5] Parsons, Brinckerhoff, Hall, and Macdonald, *op. cit.,* p. 38.

The BART studies listed below are available from: Publications, Institute of Urban and Regional Development, University of California, Berkeley, Ca. 94720. (Make checks payable to "Regents of UC.") A catalog listing all the Institute's publications is available by request at the same address.

The Full Costs of Urban Transport

Part I: Economic Efficiency in Bus Operations; Preliminary Intermodal Cost Comparisons and Policy Implications, by Peter Fisher and Philip Viton. December 1974. 156 pp. Monograph 19. $3.00.

Part II: Marginal Costs of Fixed-Rail Rapid Transit Service in the San Francisco Bay Area, by Leonard Merewitz. June 1975. 115 pp. Monograph 20. $3.00.

Part III: Automobile Costs and Final Intermodal Cost Comparisons, by Theodore E. Keeler, Kenneth A. Small, et al. July 1975. 173 pp. Monograph 21. $3.00.

A Long-Run Cost Function for Rail Rapid Transit Properties, by Leonard Merewitz and Randall J. Pozdena. September 1974. 39 pp. Working Paper 240. $1.25.

A Methodology for Selecting Urban Transportation Projects, by Randall J. Pozdena. August 1975. 183 pp. Monograph 22. $4.00.

Accessibility for Residents in the Metropolitan Environment, by Donald L. Foley. 1975. 42 pp. Reprint 127. $.75.

Auto Nonavailability as a Component of Transportation Disadvantage: A Pre-BART Review of the Bay Area Situation and the National Context, by Donald L. Foley and John Redwood III. March 1972. 33 pp. Working Paper 168. $1.25.

Bay Area Rapid Transit—Who Pays and Who Benefits?, by E. Gareth Hoachlander. July 1976. 44 pp. Working Paper 267. $1.25.

Choice of an Initial Fare Structure for the Bay Area Rapid Transit District, by Randall J. Pozdena. August 1972. 14 pp. Working Paper 181. $.75.

Cost Components for Selected Public Transportation Modes in the San Francisco Bay Area, by Douglass B. Lee, Jr. January 1974. 46 pp. Working Paper 263. $1.25.

The Costs of Private Automobile Usage to the City of San Francisco, by Douglass B. Lee. April 1972. 41 pp. Working Paper 171. $1.25.

Differentials in Personal Access to Household Motor Vehicles: Five-County San Francisco Bay Area, 1971, by Donald L. Foley. December 1972. 61 pp. Working Paper 197. $2.00.

Part III: Automobile Costs and Final Intermodal Cost Comparisons, by Theodore E. Keeler, Kenneth A. Small, et al. July 1975. 173 pp. Monograph 21. $3.00.

A Long-Run Cost Function for Rail Rapid Transit Properties, by Leonard Merewitz and Randall J. Pozdena. September 1974. 39 pp. Working Paper 240. $1.25.

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